more than 1 inch per each 100 feet. Because of the elevation and winter precipitation most of the water fell in the form of snow, and glaciers were developed. This robbing of the winds of their moisture by the Coast and Cascade Ranges dried up the lakes of eastern Oregon. Glaciers developed in this manner would not result in a reduction in the average temperature of western Oregon. On the contrary, these winds would contribute to Oregon the heat which they obtained from the warm Pacific. The moisture condensing to clouds and the cloud particles crystallizing to snow would cause these winds to give up their heat as a direct contribution to Oregon. The temperature undoubtedly was higher rather than lower. The above explanation involves no change in world climate, nor change in direction of wind, nor change in moisture content of the winds.

In the Puyallup epoch there was a subsidence of over 1,000 feet, which reduced the mountain crests to one lower than that of the present time. The moist westerly winds again were able to pass over western Oregon retaining much of their moisture which was precipitated in eastern Oregon, producing large lakes.

In the Vashon epoch elevation again took place, resulting in a second period of glaciation and the drying up of the lakes in eastern Oregon. At the close of the Vashon epoch there has been a subsidence resulting in the drowning of most of the river valleys of the Pacific Northwest. This subsidence, however, was not equal to that of the Puyallup epoch and consequently no great lakes have been developed.

Thus there were two uplifts and two glacial periods in Admiralty and Vashon time. Waters derived from their glaciers cut large valleys in western Oregon and on the flanks of the Cascades in eastern Oregon. There were two lake stages, one in pre-Admiralty and one in the Puyallup. The lakes of this second period have been drying up since that time. During the Puyallup period, and while the Admiralty glaciers were melting, aggradation on a large scale filled the Willamette Valley with sediments to an elevation of about 600 feet in the vicinity of Portland and about 150 feet in the vicinity of Eugene.

Further evidence that the climate was warm and that no chilling bodies of water existed is shown by the entire absence of marine fossils and by the presence of fossils of plants and animals requiring a warm climate. In western Oregon many fossil remains of the mammoth, mastadon, giant sloth, camel, and horse have been found. Fossil remains of the walnut, oak, willow, and sequoia have been found. The sequoia is apparently the same as the living sequoia in California at the present time and the oak and walnut are closely related to living species. These creatures could not have lived in Oregon had the climate been cold and would have been driven out if the valley had been occupied by a great sound. The glacial débris found in the Willamette Valley represent iceborne fragments which floated down the Willamette Valley while the valley was flooded by river waters in the Puyallup epoch.

This interpretation of the geology makes it possible for men to have migrated down the Pacific coast under favorable conditions and to have lived in the Willamette Valley during the glacial period. Fossil remains of a race of men antecedent to the Indians, which the white men found in this valley, have been found under conditions which would indicate that man was here during the Puyallup Epoch.

### VARIABILITY OF PRECIPITATION IN THE STATE OF WASHINGTON

By M. B. SUMMERS

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(Abstract)

The average precipitation in the State of Washington for individual months has varied between a trace and about 400 per cent of the mean of 35 years of record. The greatest variance occurs in the summer months and the most frequent variance in the region of the Cascades. In general, the greatest amount that has been received in any 12 consecutive months has been about double that of the driest similar period in the western division, and about three times the driest period in the eastern division. A singular feature of the variability in the eastern division is the fact that the July rainfall is above 150 per cent of the mean in about one year in three, and less than 50 per cent of the mean in about one year in three.

A rather rhythmic fluctuation in the precipitation curve is apparent from 1900 to 1907, with an average period of about 18 months.

### FLOODS IN THE WILLAMETTE RIVER

By EDWARD LANSING WELLS

[U. S. Weather Bureau, Portland, Oreg.]

(Author's abstract)

This paper outlines problems connected with the forecasting of floods in the Willamette River.

The drainage basin has an area of approximately 11,000 square miles, varying greatly in surface and exposure, rising from near sea level to more than 10,000 feet.

The climate is mild and equable, with precipitation ranging from 38 inches to more than 100 inches, and averaging about 65 inches. The precipitation is distinctly seasonal.

There are 12 important tributaries, and there is no stretch of more than 50 miles without the entrance of one or more of these.

Rating tables form the best basis for relating stages at successive stations, but these are not available for all stations.

The river changes character as it drops over the falls at Oregon City, becoming, in a sense, an arm of the sea.

The difference between crest stages at Salem and Portland is greater in extreme floods than in ordinary floods, and is greater when the Columbia is low, but this relation is not constant.

Rises often begin at Portland almost as soon as at upstream stations.

## NOTES, ABSTRACTS, AND REVIEWS

### EVAPORATION MEASUREMENTS IN THE SWISS ALPS

J. Maurer and Otto Lütschg in Meteorologische Zeitschrift for March, 1925, pp. 111–114, summarize their results as attained thus far. Preliminary investigations were made in 1911–12, the results being published in Meteorologische Zeitschrift, 1911, no. 12, and 1913, no. 5. In the summer of 1915, with the physical and financial resources of the Swiss Federal Bureau of Water Control at their service, intensive studies were begun.

These were carried on at first with open circular vessels of sheet zinc (evaporation pans) of.30 and 50 cm. diameter and depth, respectively, supplemented by Livingston porous cup atmometers and glass vessels of 24 and 28 cm. diameter and 8 cm. depth, in the upper Saas Valley at the various altitudes indicated for the stations for which data are plotted in Figure 1, these data representing conditions in 1920. Evaporation measurements were always accompanied by observations of the meteorological elements. Evaporation pan measurements were carried out on Lake Mattmark, at about 2,100 meters above sea level, during the summers of 1915 and 1916. The summer of 1915 gave 24-hour evaporation values ranging between 6.2 mm. and 2 mm., according to the weather. The maximum value represents a warm and entirely clear period with light north wind. In 1916 the July and August 24-hour values ranged from 1.6 mm. and 3.4 mm.

The principal series of observations was made at the Hopschensee, 2,017 m. above sea level, west of the Simplon Pass, between July 25 and October 23, 1921. These were carried through by means of hydrometrical methods, taking account of the inflow and outflow and direct precipitation which affected the level of the lake. Coincident with these, a series of porous cup atmometer and glass vessel determinations was made in the meadow directly on the lake shore, the corresponding meteorological observations being taken also.

Table 1 for the Hopschensee summarizes evaporation from this lake by certain calendar groups of days without regard to weather conditions. Table 1a for the same lake divides the data for the same total period into groups according to weather type, a much more significant procedure. Table 2 summarizes the results obtained by